We claim:

1. A patterned polymer microgel, comprising a polymer film and a substrate on which said polymer film is supported, said polymer film including a superficial pattern having details in the submicron range and a non-patterned portion outside of said superficial pattern, said superficial pattern being distinguished from said non-patterned portion by a distinguishing property.

2. The patterned polymer microgel of Claim 1, wherein said substrate has an exposed area which does not support the polymer film, said superficial pattern being distinguished from said exposed area by said distinguishing property.

3. The patterned polymer microgel of Claim 1, wherein said superficial pattern is irregularly arranged.

4. The patterned polymer microgel of Claim 1, wherein said distinguishing property has an arbitrary distribution within said superficial pattern.

5. The patterned polymer microgel of Claim 1, wherein said polymer is a homopolymer.

6. The patterned polymer microgel of Claim 1, wherein said polymer is a copolymer.

7. The patterned polymer microgel of Claim 1, wherein said polymer film is a multilayer film comprising layers of at least a first polymer and a second polymer, said layers adhering to each other by a bonding mechanism selected from the group consisting of hydrogen bonding, electrostatic bonding and a combination of hydrogen bonding and electrostatic bonding.

8. The patterned polymer microgel of Claim 1, said distinguishing property being the degree of cross-linking of said polymer.

9. The patterned polymer microgel of Claim 1, said distinguishing property being the degree of swelling of said polymer when said polymer film is exposed to a solvent.

10. The patterned polymer microgel of Claim 1, said distinguishing property being the affinity of said polymer for adsorption of a protein.

11. The patterned polymer microgel of Claim 10, further comprising a protein adsorbed to said film within said superficial pattern.

12. The patterned polymer microgel of Claim 1, said distinguishing property being the affinity of said polymer for adhesion of a cell.

13. The patterned polymer microgel of Claim 12, further comprising a cell adhered to said film within said superficial pattern.

14. The patterned polymer microgel of Claim 1, further comprising a bioactive molecule reversibly bonded to said layer within said superficial pattern.

15. The patterned polymer microgel of Claim 1, wherein said superficial pattern comprises a pH-sensitive microgel.

16. The patterned polymer microgel of Claim 1, further comprising an inorganic substrate, said layer being chemically bonded to said inorganic substrate.

17. A method of making a patterned polymer microgel, comprising the steps of:

forming a dry polymer film on a substrate; and

exposing a portion of the dry polymer film to a source of electron radiation under high vacuum so as to form a pattern of exposed polymer film within the portion of the dry polymer film.

18. The method of Claim 17, further comprising the step of removing a portion of the dry polymer film from the substrate so as to leave the pattern of exposed polymer film on the substrate.

19. The method of Claim 17, wherein the source of electron radiation is a focused electron beam and the step of exposing a portion of the dry polymer film to the source of radiation energy includes the step of rastering the focused electron beam across a series of positions over the portion of dry polymer film.

20. The method of Claim 19, wherein the step of exposing a portion of the dry polymer film to the source of electron radiation includes the step of modulating the intensity of the exposure of the portion of dry polymer film at each of the positions so that the intensity of the exposure within the pattern varies along a dimension parallel to a surface of the dry polymer film.

21. The method of Claim 19, wherein the dry polymer film is exposed to radiation energies in a range of from about 500 eV to about 300 keV and the focused electron beam has a characteristic diameter of from about 1 nanometer to about 1 micron.

22. The method of Claim 19, wherein the dry polymer film is exposed to radiation energies in a range of from about 500 eV to about 20 keV and the focused electron beam has a characteristic diameter of from about 1 nanometer to about 1 micron.

23. The method of Claim 17, wherein the step of exposing a portion of the dry polymer film to a source of electron radiation includes the steps of forming a patterned radiation mask and then placing the patterned radiation mask between the portion of the dry polymer film and the source of electron radiation so that areas of the film outside of the pattern are exposed to substantially less radiation energy than are the areas of the film within the pattern.

24. The method of Claim 23, wherein the portion of the dry polymer film is exposed to radiation energies in a range of from about 500 eV to about 300 keV

25. The method of Claim 23, wherein the portion of the dry polymer film is exposed to radiation energies in a range of from about 10 keV to about 300 keV.

26. The method of Claim 17, wherein the high vacuum is on the order of 10^{-6} Torr.

27. The method of Claim 18, wherein the substrate is an inorganic substrate.

28. A method of controlling protein adsorption on a polymer film, comprising the steps of:

forming a dry polymer film on a substrate, said polymer film being resistant to the adsorption of proteins;

exposing a portion of the dry polymer film to a source of electron radiation under high vacuum so as to form a pattern of highly cross-linked polymer film within the portion of dry polymer film; and

contacting the dry polymer film with a medium containing a protein, whereby the protein adsorbs to the pattern of highly cross-linked polymer film.

29. The method of Claim 28, wherein the source of electron radiation is a focused electron beam and the step of exposing a portion of the dry polymer film to the source of electron radiation includes the step of rastering the focused electron beam across a series of positions over the portion of dry polymer film.

30. The method of Claim 29, wherein the step of exposing a portion of the dry polymer film to the source of electron radiation includes the step of modulating the intensity of the exposure of the portion of dry polymer film at each of the positions so that the intensity of the exposure within the pattern varies along a dimension parallel to a surface of the dry polymer film.

31. The method of Claim 28, wherein the step of exposing a portion of the dry polymer film to a source of electron radiation includes the steps of forming a patterned radiation mask that passes radiation through the pattern and then placing the patterned radiation mask between the portion of the dry polymer film and the source of radiation energy so that areas of the film outside of the pattern are exposed to substantially less radiation energy than are the areas of the film within the pattern.

32. A method of controlling cell adhesion on a polymer film, comprising the steps of:

forming a dry polymer film on a substrate, said polymer film being resistant to cell adhesion;

exposing a portion of the dry polymer film to a source of electron radiation under high vacuum so as to form a pattern of highly cross-linked polymer film within the portion of dry polymer film; and

contacting the dry polymer film with a medium having cells therein, whereby a cell adheres to the highly cross-linked polymer film within the pattern.

33. The method of Claim 32, wherein the source of electron radiation is a focused electron beam and the step of exposing a portion of the dry polymer film to the source of electron radiation includes the step of rastering the focused electron beam across a series of positions over the portion of dry polymer film.

34. The method of Claim 33, wherein the step of exposing a portion of the dry polymer film to the source of electron radiation includes the step of modulating the intensity of the exposure of the portion of dry polymer film at each of the positions so that the intensity of the exposure within the pattern varies along a dimension parallel to a surface of the dry polymer film.

35. The method of Claim 32, wherein the step of exposing a portion of the dry polymer film to a source of electron radiation includes the steps of forming a patterned radiation mask that passes radiation through the pattern and then placing the patterned radiation mask between the portion of the dry polymer film and the source of radiation energy so that areas of the film outside of the pattern are exposed to substantially less radiation energy than are the areas of the film within the pattern.